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Millennium-Long Reconstructions of Cool and Warm Season Precipitation Over the Southeastern and Southwestern United States

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Abstract: Some of the longest and most climate sensitive tree-ring chronologies in the world have been developed from arid-site conifers in the southwestern United States and from swamp grown bald cypress in the Southeast. These chronologies have been used to reconstruct precipitation, streamflow, Palmer drought severity indices (PDSI), and the larger-scale ocean atmospheric forcing of interannual climate variability over North America. Ironically, however, most of these annual ring width chronologies integrate the effects of precipitation and temperature during the winter, spring, and early summer, and do not provide a simple proxy for summer precipitation. The integration of cool and early warm season precipitation is ideal for the estimation of the long-term soil moisture balance as embodied in the PDSI, but annual ring width cannot resolve separate cool and warm season precipitation totals nor the distinctive modes of atmospheric circulation responsible for interannual and decadal variability in each season. The annual growth rings of many conifers (e.g., Pseudotsuga menziesii, Pinus Ponderosa, Taxodium distichum) exhibit a distinctive anatomical transition from earlywood (EW) to latewood (LW) that segments the annual ring into the components formed in the spring and summer. These exactly-dated components of the annual ring can be precisely measured and separately calibrated with winter spring and summer precipitation. The proposed research will re-analyze existing tree ring collections from the Southeast and Southwest to derive separate millennium-long reconstructions of cool and warm season precipitation. The proposed reconstruction will be used to document seasonal precipitation regimes during megadroughts and pluvials of the past millennium, test the frequency modulation of the seasonal reconstructions at ENSO, decadal, bidecadal, and multidecadal timescales, analyze the evolution of these important frequency components in seasonal precipitation from the Medieval era to Little Ice Age and into the modern period of anthropogenic climate change. In and out-of-phase anomalies in seasonal precipitation between the southeast and southwestern United States have been linked to longwave circulation regimes over North America and to solar irradiance changes in GCM simulations, and will be investigated on interannual to multidecadal time scales. The reconstructions will also be used to investigate the conditional predictability of warm season precipitation based on anomalies reconstructed during the preceding cool season, as has been hypothesized for monsoon onset over the Southwest based on preceding cool season precipitation. The proposed seasonal precipitation reconstructions will provide a more complete description of droughts, megadroughts, and pluvials over the southeastern and southwestern United States for the past millennium, and will provide key empirical data need to test dynamical explanations of natural and anthropogenic climate change. The proposed seasonal reconstructions will frame the current and predicted aridity trend over subtropical

North America in the context of natural variability and will be relevant to regional and federal water and energy policy.